

Vehicle Situation Data Message Definition

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Vehicle Situation Data Message

Vehicle Situation Data messages (VSM) are sent to the Local Current Situation Data Warehouse (LCSDW) where they are distributed to Situation Data Processing Centers to be aggregated and processed. Information from processed VSMs can be used to assess traffic patterns, traffic flow, weather conditions, etc. in a given geographic area. This information is then passed along to infrastructure users (Traffic Management Centers, etc.) for use in traffic operations, management, and planning and to downstream vehicles to enable drivers to make informed decision regarding their travel route.

This document defines all of the Data Frames (DF) and Data Elements (DE) contained in the VSM and provides guidance as to when individual data records should be recorded and when VSMs should be generated and transmitted to the LCSDW.

1. Message: MSG_VehSitDataMessage (VSM)

The VSM is used to send bundles of vehicle situation data records to the Local Current Situation Data Warehouse (LCSDW). This message contains SAE J2735 data elements and new data elements developed for specific applications. All new data elements are defined in the same style as J2735 for consistency. The ASN.1 Notation for the VSM is listed in Table 1.

```
VehSitDataMessage ::= SEQUENCE {
    msgID          DSRCmsgID,
    type           vsmType,
    path           PathHistory,
    Bundle SEQUENCE (SIZE (1..10)) OF VehSitRcd,    --sets of situation data
                                                    --records
    Crc            MsgCRC,
}
```

Table 1: VehSitDataMessage

1.1. Data Element: DE_DSRCmsgID

DSRCmsgID identifies a message as a VehSitDataMessage. The VehSitDataMessage type is not defined in J2735, therefore a new DSRCmsgID, 138 (0x8A), is defined. The ASN.1 Notation is listed in Table 2.

```
DSRCmsgID ::= ENUMERATED {
    vehSitDataMessage (138), --VSM
}
```

Table 2: DE_DSRCmsgID

1.2. Data Element: DE_vsmType

vsmType indicates the type of VehSitRcds contained in a VehSitDataMessage. All VehSitRcds contain the fundamental data elements and can also contain any and all combinations of vehicle status, weather, environmental, and electric vehicle data. All data types are defined in the **Data Frame: DF_VehSitRcd** section. The ASN.1 Notation is listed in Table 3.

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```
vsmType ::= ENUMERATED {  
    fund          (0),  --B'00000000, VehSitRcd that only contain  
                        --the fundamental data elements  
  
    vehstat       (1),  --B'00000001, VehSitRcd that contain the  
                        --Fundamental record plus the J2735  
                        --VehicleStatus data Frame  
  
    weather       (2),  --B'00000010, VehSitRcd that contain the  
                        --Fundamental record plus the weather data  
  
    env           (4),  --B'00000100, VehSitRcd that contain the  
                        --Fundamental record plus Environmental data  
  
    elveh         (8),  --B'00001000, VehSitRcd that contain the  
                        --Fundamental record plus Electric Vehicle data}  
}
```

Table 3: DE_vsmType

1.3. Data Frame: DF_PathHistory

PathHistory contains the location and time when each VehSitRcd was recorded, providing an overall geographic region and time span to the VSM. The ASN.1 Notation is listed in Table 4.

```
PathHistory ::= SEQUENCE{  
    anchorpnt      FullPositionVector,  
    cnt            Count,          (-- # of offsets)  
    pntType        PathHistoryPointTpe-04,  
}
```

Table 4: DF_PathHistory

1.3.1. Data Frame: DF_FullPositionVector

FullPositionVector is the location and time when the last, most recent, VehSitRcd was recorded. The ASN.1 Notation is listed in Table 5.

```
FullPositionVector ::= SEQUENCE {  
    utcTime        DDateTime,    (--DF_VehSitRcd1 DDatetime)  
    long           Longitude,    (--DF_VehSitRcd1 Position3D long)  
    lat            Latitude,     (--DF_VehSitRcd1 Position3D lat)  
    elev           Elevation,    (--DF_VehSitRcd1 Position3D elev)  
}
```

Table 5: DF_FullPositionVector

1.3.2. Data Element DE_Count

Count indicates the number of offsets in PathHistory. Count +1 indicates the number of VehSitRcds contained in the VSM. The ASN.1 Notation is listed in Table 6.

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```
Count ::= INTEGER (0..23)      --indicates the number of offsets contained in
                                --PathHistory.
                                --Count +1 indicates the number of VehSitRcds in
                                --the VMS.
```

Table 6: DE_Count

1.3.3. Data Frame: DF_PathHistoryPointTpe-04

PathHistroyPointType=04 offsets represent the location and time the VehSitRcds were recorded. The anchor point, in this case FullPositionVector, is the last, most recent, VehSitRcd recorded. Each offset is relative to the previous (i.e. offset 1 is relative to the anchor point, offset2 is relative to offset 1, offset 3 is relative to offset 2, etc.). A PathHistoryPointType-04 offset is included for VehSitRcds 2-N in the VSM. The ASN.1 Notation is listed in Table 7.

```
PathHistoryPointType-04 ::= OCTET STRING (SIZE(8))
-- To be made up of packed bytes as follows:
-- latOffset INTEGER (-131072..131071) (18 signed bits)
-- longOffset INTEGER (-131072..131071) (18 signed bits)
-- in 1/10th micro degrees
-- value 131071 to be used for 131071 or greater
-- value -131071 to be used for -131071 or less
-- value -131072 to be used for unavailable lat or long

-- elevationOffset INTEGER (-2048..2047), (12 signed bits)
-- LSB units of 10 cm
-- value 2047 to be used for 2047 or greater
-- value -2047 to be used for -2047 or greater
-- value -2048 to be unavailable

-- timeOffset INTEGER (0..65535), (16 unsigned bits)
-- LSB units of of 10 mSec
-- value 65534 to be used for 65534 or greater
-- value 65535 to be unavailable
```

Table 7: DF_PathHistoryPointType

1.4. Data Frame: DF_VehSitRcd

VehSitRcd contain the status of various vehicle sensors at a specific location at a specific point in time. VehSitRcds are comprised on fundamental Data Frames and Data Elements that are contained in every VehSitRcd. Other Data Frames, indicated as Optional, are only contained in VehSitRcds if the vehicle is properly equipped. The ASN.1 Notation is listed in Table 8.

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VehSitRcd ::= SEQUENCE {			
tempID	TemporaryID,		--from BSM Part I
time	DDateTime,		
pos	Position3D,		
speed	TransmissionAndSpeed,		--from BSM Part I
heading	Heading,		--from BSM Part I
stwhangle	SteeringWheelAngle,		--from BSM Part I
4wayacc	AccelerationSet4Way,		--from BSM Part I
brakes	BrakeSystemStatus,		--from BSM Part I
size	VehicleSize,		--from BSM Part I
vehstat	VehicleStatus	Optional,	
weather	Weather	Optional,	--as observed by vehicle
			--sensors
env	Environmental	Optional,	--as observed by vehicle
			--sensors
elveh	ElectricVeh	Optional,	--data relating to vehicle
			--status unique to Electric
			--Vehicles (state of
			--charge, range, etc.)
}			

Table 8: DE_VehSitRcd

1.4.1. Fundamental Data

The following, fundamental, data elements are contained in each VehSitRcd:

- TemporaryID
- DDateTime
- Position3D
- TransmissionAndSpeed
- Heading
- SteeringWheelAngle
- AccelerationSet4Way
- BrakeSystemStatus
- VehicleSize

These data elements are part of the J2735 Basic Safety Message (BSM) Part I and have the same value as the Part I elements when captured as part of the VehSitRcd.

1.4.2. Data Frame: DF_VehicleStatus

VehicleStatus is the J2735 VehicleStatus Data Frame contained in Part II of the BSM and is comprised of the values and status of various vehicle sensors and systems at the time the VehSitRcd is recorded. See J2735 for the ASN.1 Notation.

1.4.3. Data Frame: DF_Weather

Weather contains the status of various vehicle sensors related to the weather conditions at a specific location at a specific point in time. If the Weather Data Frame is populated, weather related J2735 Data Elements shall NOT be included in the J2735 VehicleStatus Data Frame. The ASN.1 Notation is listed in Table 9.

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Weather ::= SEQUENCE {			
wipers Sequence {			
statFrnt	WiperStatusFront		
rateFrnt	WiperRate	Optional,	
statRear	WiperStatusRear	Optional,	
rateRear	WiperRate	Optional,	
} Optional,			
airTemp	AmbientAirTemperature	Optional,	
sunSen	SunSensor	Optional,	
rainSen	RainSensor	Optional,	
airPres	AmbientAirPressure	Optional,	
lights	HeadlightStatus	Optional,	
weatherReport Sequence {			
isRaining	NTCIP.EssPrecipYesNo,		
rainRate	NTCIP.EssPrecipRate	Optional,	
precipSituation	NTCIP.EssPrecipSituation	Optional,	
solarRadiation	NTCIP.EssSolarRadiation	Optional,	
friction	NTCIP.EssMobileFriction	Optional	
} Optional,			
... -- # Additional Content			
}			

Table 9: DF_Weather

1.4.4. Data Frame: DF_Environmental

Environmental contains the status of various vehicle sensors related to fuel consumption, emissions, fuel economy, etc. at a specific location at a specific point in time.

Note: data elements contained in the Environmental data frame are still in development.

The ASN.1 Notation is listed in Table 10.

Environmental ::= SEQUENCE {			
fuelCon	FuelConsumption,	--new, definition is TBD	
emiss	Emissions,	--new, definition is TBD	
fuelEcon	FuelEconomy,	--new, definition is TBD	
... -- # Additional Data Elements			
}			

Table 10: DF_Environmental

1.4.4.1. Data Element: DE_FuelConsumption

FuelConsumption TBD

The ASN.1 Notation is listed in Table 11.

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```
FuelConsumption ::= TBD
```

Table 11: DE_FuelConsumption

1.4.4.2. Data Element: DE_Emissions

Emissions TBD

The ASN.1 Notation is listed in Table 12.

```
Emissions ::= TBD
```

Table 12: DE_Emissions

1.4.4.3. Data Element: DE_FuelEconomy

FuelEconomy TBD

The ASN.1 Notation is listed in Table 13.

```
FuelEconomy ::= TBD
```

Table 13: DE_FuelEconomy

1.4.5. Data Frame: DF_ElectricVeh

ElectricVeh contains the status of various vehicle sensors and systems, unique to Electric Vehicles, at a specific location at a specific point in time.

Note: data elements contained in the ElectricVeh data frame are still in development.

The ASN.1 Notation is listed in Table 14.

```
ElectricVeh ::= SEQUENCE {  
    soc          StateOfCharge,      --Veh Battery State of Charge  
    cap          Capacity,           --Capacity of the Veh Battery  
    range        Range,              --driving range of veh based on soc  
    ... -- # Additional Data Elements  
}
```

Table 14: DF_ElectricVeh

1.4.5.1. Data Element: DE_StateOfCharge

StateOfCharge TBD

20131230

This item is for the Southeast Michigan Architecture implementation ONLY. It should not be considered program direction until confirmed by your Contracting Officer.

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The ASN.1 Notation is listed in Table 15.

```
StateOfCharge ::= TBD
```

Table 15: DE_StateOfCharge

1.4.5.2. Data Element: DE_Capacity

Capacity TBD

The ASN.1 Notation is listed in Table 16.

```
Capacity ::= TBD
```

Table 16: DE_Capacity

1.4.5.3. Data Element: DE_Range

Range TBD

The ASN.1 Notation is listed in Table 17.

```
Range ::= TBD
```

Table 17: DE_Range

2. 2014 SEMI VSM Management Strategy

This Section provides the strategy utilized in the initial implementation of the VSM for the 2014 Southeast Michigan Architecture.

2.1. VehSitRcds order within a VSM

VehSitRcds are arranged in ascending order relative to the time in which they were recorded; the last, or 10th, (most recent) VehSitRcd recorded is the first VehSitRcd in the message and the first VehSitRcd recorded is the last VehSitRcd in the message.

2.2. VehSitRcd Generation

- VehSitRcds are recorded when a BSM is generated and while the vehicle is traveling at 24 kph (~15 mph) or greater.
- Following Ignition-on, VehSitRcds are not recorded until one of the following conditions are met:
 - A random Time window of between 10 minutes and 20 minutes, with a 1 minute resolution has passed, or

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- The vehicle has traveled a random distance of between 500m and 1000m, with a 1m resolution.
- After every 10 VehSitRcds recorded a VSM is generated and put in a queue to be transmitted.
 - VSM will be generated roughly once a second.

2.3. VehSitRcd and VSM Storage:

- VehSitRcds and VSMs are stored for 30 minutes after collection\generation then deleted.
 - Up to 180000 VehSitRcds or 1800 VSM could be stored at any given time.
- All stored VehSitRcds and VSMs are deleted upon security credential change.
- All stored VehSitRcds and VSMs are deleted when the vehicle crosses LCSDW geographic boundaries.
- All stored VehSitRcds and VSMs are deleted within 5 seconds after Ignition-off

2.4. VSM Transmission to LCSDW:

- VSMs are transmitted using a Last-In\ First-Out strategy
- DSRC: VehSitDataMessages are sent to the relevant Local Current Situation Data Warehouse when the vehicle encounters a DSRC Roadside Unit (RSU) advertising the “General IP Service” PSID 0xBFE1.

3. Sample Message

This Section provides a Sample VSM. Figure 1 depicts a vehicle’s location at which 10 VehSitRcds were captured along with the average heading and speed of the vehicle during the time the VehSitRcds were captured. Table 18 contains the data elements and their values and Table 19 contains the ASN.1 Hex encoding for the message.

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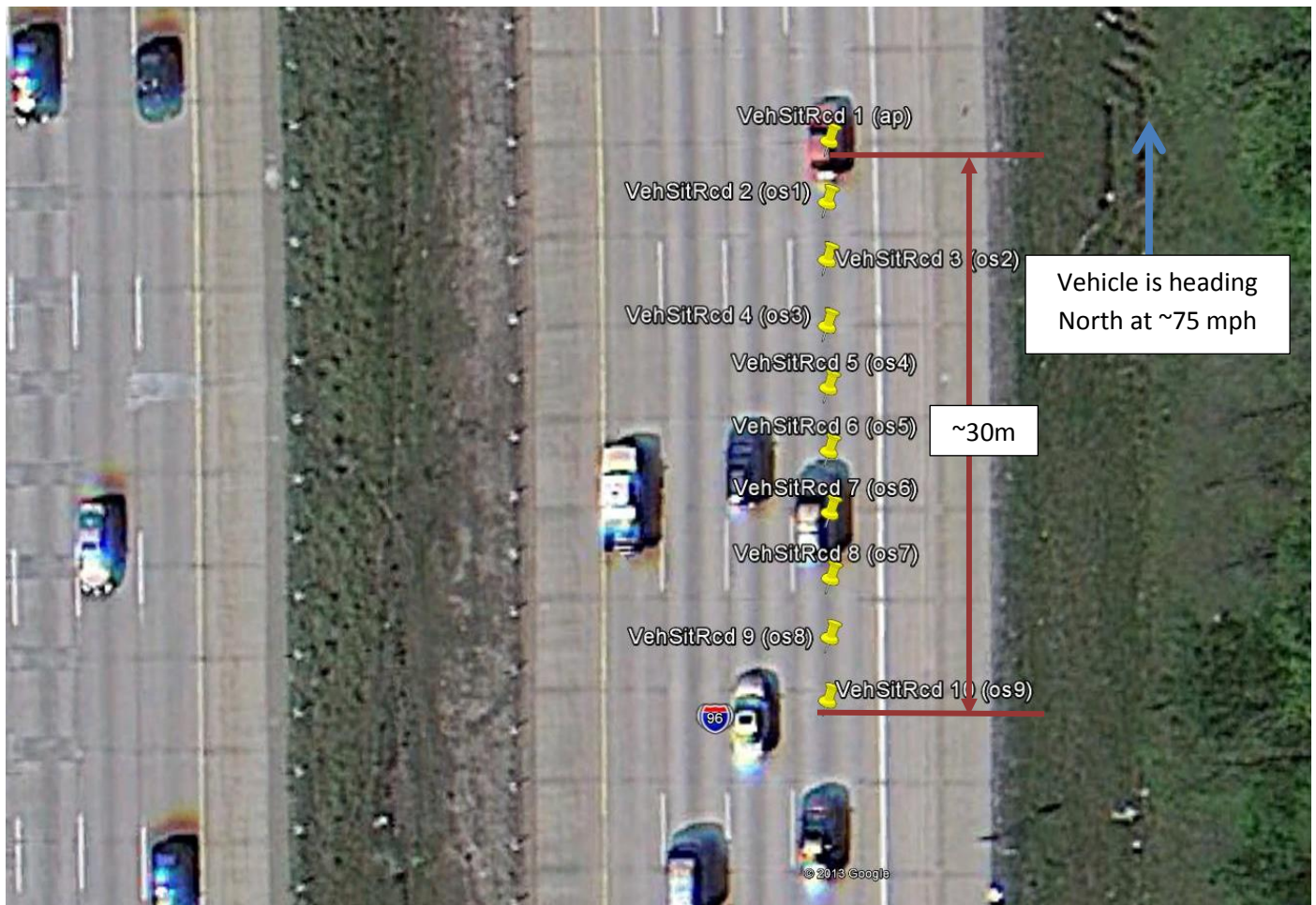


Figure 1: Vehicle location, heading and speed for Sample Message

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Data Elements		Dec	Hex	Units	Comments
msgID		138	8A		<new ID>
Type		0	00		(--new)
PathHistory					(--unique identifier (packetID))
	FullPositionVector				
	DDateTime		07DD0C09091E7530		(--DDateTime of VehSitRcd 1)
		DYear	2013	07DD	
		DMonth	12	0C	
		DDay	9	09	
		DHour	9	09	
		DMinute	30	1E	
		DSecond	30.00	7530	
	Long		42.44783187		(--Position3D of VehSitRcd 1)
	Lat		-83.43090838		
	elevation		840	20D0	m
	Count		9	09	(--number of offsets)
	PathHistoryPointType-04				
	latOffset1		-18	cm	(--VehSitRcd 2 Position3D- VehSitRcd 1 Position3D)
	longOffset1		-332	cm	
	elevationOffset1		0	m	
	timeOffset1		-0.100	Seconds	(--VehSitRcd 2 DDateTime- VehSitRcd 1 DDateTime)
	latOffset2		-7	cm	(--VehSitRcd 3 Position3D- VehSitRcd 2 Position3D)
	longOffset2		-312	cm	
	elevationOffset2		0	m	
	timeOffset2		-0.100	Seconds	(--VehSitRcd 3 DDateTime- VehSitRcd 2 DDateTime)
	latOffset3		-8	cm	
	longOffset3		-358	cm	
	elevationOffset3		0	m	
	timeOffset3		-0.100	Seconds	
	latOffset4		0	cm	
	longOffset4		-334	cm	
	elevationOffset4		0	m	
	timeOffset4		-0.100	Seconds	
	latOffset5		-5	cm	
	longOffset5		-344	cm	
	elevationOffset5		-100	m	
	timeOffset5		-0.100	Seconds	
	latOffset6		-2	cm	
	longOffset6		-334	cm	
	elevationOffset6		0	m	
	timeOffset6		-0.100	Seconds	
	latOffset7		-5	cm	
	longOffset7		-356	cm	

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Data Elements			Dec	Hex	Units	Comments	
		elevationOffset7	0		m		
		timeOffset7	-0.100		Seconds		
		latOffset8	-11		cm		
		longOffset8	-322		cm		
		elevationOffset8	0		m		
		timeOffset8	-0.100		Seconds		
		latOffset9	-19		cm	(--VehSitRcd 10 Position3D- VehSitRcd 9 Position3D)	
		longOffset9	-344		cm		
		elevationOffset9	0		m		
		timeOffset9	-0.100		Seconds	(--VehSitRcd 10 DDateTime- VehSitRcd 9 DDateTime)	
Bundle						(--new)	
	VehSitRcd 1					(--new)	
		TemporaryID	536952534	20013ED6			
		DDateTime					
		DYear	2013	07DD			
		DMonth	12	0C			
		DDay	9	09			
		DHour	9	09			
		DMinute	30	1E			
		DSecond	30.000	7530			
		Position3D					
		Lat	42.44783187				
		Long	-83.43090838				
		elevation	842	20E4			
	TransmissionAndSpeed		58994	E672		Transmission State=7, Speed = 33m/s	
	Heading		104	68		1.3 degrees	
	SteeringWheelAngle		1	1		1.5 deg	
	AccelerationSet4Way		2199009296384	1FFFF2B0000		Long:1, Lat:-1, vert=43 (0.86G), yaw=0	
	BrakeSystemStatus		0	0			
	VehicleSize		4261100	4104EC		Width: 260cm, Length: 236cm	
	VehSitRcd 2						
			TemporaryID	536952534	20013ED6		
			DDateTime				
	DYear	2013	07DD				
	DMonth	12	0C				
	DDay	9	09				
	DHour	9	09				
	DMinute	30	1E				
	DSecond	29.900	74CC				
Position3D							
	Lat	42.44780194					

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Data Elements		Dec	Hex	Units	Comments
	Long	-83.4309106			
	elevation	842	20E4		
	TransmissionAndSpeed	58994	E672		Transmission State=7, Speed = 33m/s
	Heading	104	68		1.3 degrees
	SteeringWheelAngle	1	1		1.5 deg
	AccelerationSet4Way	2199009296384	1FFFF2B0000		Long:1, Lat:-1, vert=43 (0.86G), yaw=0
	BrakeSystemStatus	0	0		
	VehicleSize	4261100	4104EC		Width: 260cm, Length: 236cm
	VehSitRcd 3				
	TemporaryID	536952534	20013ED6		
	DDateTime				
	DYear	2013	07DD		
	DMonth	12	0C		
	DDay	9	09		
	DHour	9	09		
	DMinute	30	1E		
	DSecond	29.800	7468		
	Position3D				
	Lat	42.44777385			
	Long	-83.4309106			
	elevation	842	20E4		
	TransmissionAndSpeed	58994	E672		Transmission State=7, Speed = 33m/s
	Heading	104	68		1.3 degrees
	SteeringWheelAngle	1	1		1.5 deg
	AccelerationSet4Way	2199009296384	1FFFF2B0000		Long:1, Lat:-1, vert=43 (0.86G), yaw=0
	BrakeSystemStatus	0	0		
	VehicleSize	4261100	4104EC		Width: 260cm, Length: 236cm
	VehSitRcd 4				
	TemporaryID	536952534	20013ED6		
	DDateTime				
	DYear	2013	07DD		
	DMonth	12	0C		
	DDay	9	09		
	DHour	9	09		
	DMinute	30	1E		
	DSecond	29.700	7404		
	Position3D				
	Lat	42.44774161			
	Long	-83.43091245			
	elevation	842	20E4		

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Data Elements		Dec	Hex	Units	Comments
	TransmissionAndSpeed	58994	E672		Transmission State=7, Speed = 33m/s
	Heading	104	68		1.3 degrees
	SteeringWheelAngle	1	1		1.5 deg
	AccelerationSet4Way	2199009296384	1FFFF2B0000		Long:1, Lat:-1, vert=43 (0.86G), yaw=0
	BrakeSystemStatus	0	0		
	VehicleSize	4261100	4104EC		Width: 260cm, Length: 236cm
	VehSitRcd 5				
	TemporaryID	536952534	20013ED6		
	DDateTime				
		DYear	2013	07DD	
		DMonth	12	0C	
		DDay	9	09	
		DHour	9	09	
		DMinute	30	1E	
		DSecond	29.600	73A0	
	Position3D				
		Lat	42.44771154		
		Long	-83.43091249		
		elevation	842	20E4	
	TransmissionAndSpeed	58994	E672		Transmission State=7, Speed = 33m/s
	Heading	104	68		1.3 degrees
	SteeringWheelAngle	1	1		1.5 deg
	AccelerationSet4Way	2199009296384	1FFFF2B0000		Long:1, Lat:-1, vert=43 (0.86G), yaw=0
	BrakeSystemStatus	0	0		
	VehicleSize	4261100	4104EC		Width: 260cm, Length: 236cm
	VehSitRcd 6				
	TemporaryID	536952534	20013ED6		
	DDateTime				
		DYear	2013	07DD	
		DMonth	12	0C	
		DDay	9	09	
		DHour	9	09	
		DMinute	30	1E	
		DSecond	29.500	733C	
	Position3D				
		Lat	42.44768053		
		Long	-83.43091316		
		elevation	841	20DA	
	TransmissionAndSpeed	58994	E672		Transmission State=7, Speed = 33m/s

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Data Elements		Dec	Hex	Units	Comments
	Heading	104	68		1.3 degrees
	SteeringWheelAngle	1	1		1.5 deg
	AccelerationSet4Way	2199009296384	1FFFF2B0000		Long:1, Lat:-1, vert=43 (0.86G), yaw=0
	BrakeSystemStatus	0	0		
	VehicleSize	4261100	4104EC		Width: 260cm, Length: 236cm
VehSitRcd 7					
	TemporaryID	536952534	20013ED6		
	DDateTime				
		DYear	2013	07DD	
		DMonth	12	0C	
		DDay	9	09	
		DHour	9	09	
		DMinute	30	1E	
		DSecond	29.400	72D8	
	Position3D				
		Lat	42.44765038		
		Long	-83.43091335		
		elevation	841	20DA	
	TransmissionAndSpeed	58994	E672		Transmission State=7, Speed = 33m/s
	Heading	104	68		1.3 degrees
	SteeringWheelAngle	1	1		1.5 deg
	AccelerationSet4Way	2199009296384	1FFFF2B0000		Long:1, Lat:-1, vert=43 (0.86G), yaw=0
	BrakeSystemStatus	0	0		
	VehicleSize	4261100	4104EC		Width: 260cm, Length: 236cm
VehSitRcd 8					
	TemporaryID	536952534	20013ED6		
	DDateTime				
		DYear	2013	07DD	
		DMonth	12	0C	
		DDay	9	09	
		DHour	9	09	
		DMinute	30	1E	
		DSecond	29.300	7274	
	Position3D				
		Lat	42.44761825		
		Long	-83.43091395		
		elevation	841	20DA	
	TransmissionAndSpeed	58994	E672		Transmission State=7, Speed = 33m/s
	Heading	104	68		1.3 degrees
	SteeringWheelAngle	1	1		1.5 deg

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Data Elements		Dec	Hex	Units	Comments
	AccelerationSet4Way	2199009296384	1FFFF2B0000		Long:1, Lat:-1, vert=43 (0.86G), yaw=0
	BrakeSystemStatus	0	0		
	VehicleSize	4261100	4104EC		Width: 260cm, Length: 236cm
	VehSitRcd 9				
	TemporaryID	536952534	20013ED6		
	DDateTime				
		DYear	2013	07DD	
		DMonth	12	0C	
		DDay	9	09	
		DHour	9	09	
		DMinute	30	1E	
		DSecond	29.200	7210	
	Position3D				
		Lat	42.44758921		
		Long	-83.43091534		
		elevation	841	20DA	
	TransmissionAndSpeed	58994	E672		Transmission State=7, Speed = 33m/s
	Heading	104	68		1.3 degrees
	SteeringWheelAngle	1	1		1.5 deg
	AccelerationSet4Way	2199009296384	1FFFF2B0000		Long:1, Lat:-1, vert=43 (0.86G), yaw=0
	BrakeSystemStatus	0	0		
	VehicleSize	4261100	4104EC		Width: 260cm, Length: 236cm
	VehSitRcd 10				
	TemporaryID	536952534	20013ED6		
	DDateTime	-			
		DYear	2013	07DD	
		DMonth	12	0C	
		DDay	9	09	
		DHour	9	09	
		DMinute	30	1E	
		DSecond	29.100	71AC	
	Position3D				
		Lat	42.44755818		
		Long	-83.43091764		
		elevation	841	20DA	
	TransmissionAndSpeed	58994	E672		Transmission State=7, Speed = 33m/s
	Heading	104	68		1.3 degrees
	SteeringWheelAngle	1	1		1.5 deg
	AccelerationSet4Way	2199009296384	1FFFF2B0000		Long:1, Lat:-1, vert=43 (0.86G), yaw=0

Vehicle Situation Data Message Definition

This document applies to the 2014 Southeast Michigan Architecture. It is intended to be used to document discussions among the stakeholders in that implementation. It is not intended to replace any standards development activity or device definition specification.

Data Elements		Dec	Hex	Units	Comments
	BrakeSystemStatus	0	0		
	VehicleSize	4261100	4104EC		Width: 260cm, Length: 236cm

Table 18

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Table 19